Suzaku observations of the Hot Interstellar Medium (aka MBM12 and a nearby field)

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Goals

Determine the temperature and emission measure of the local and distant components of the soft X-ray background emission.

MBM12 is a nearby molecular cloud that serves as an excellent "curtain" for separating local and distant soft X-ray emission. We observed MBM12 for ~100 ksec and an off-cloud position for ~70 ksec immediately thereafter.

Suzaku's low energy response & resolution, combined with the low background of the XIS, allowed us to separate and measure the oxygen lines in both datasets.

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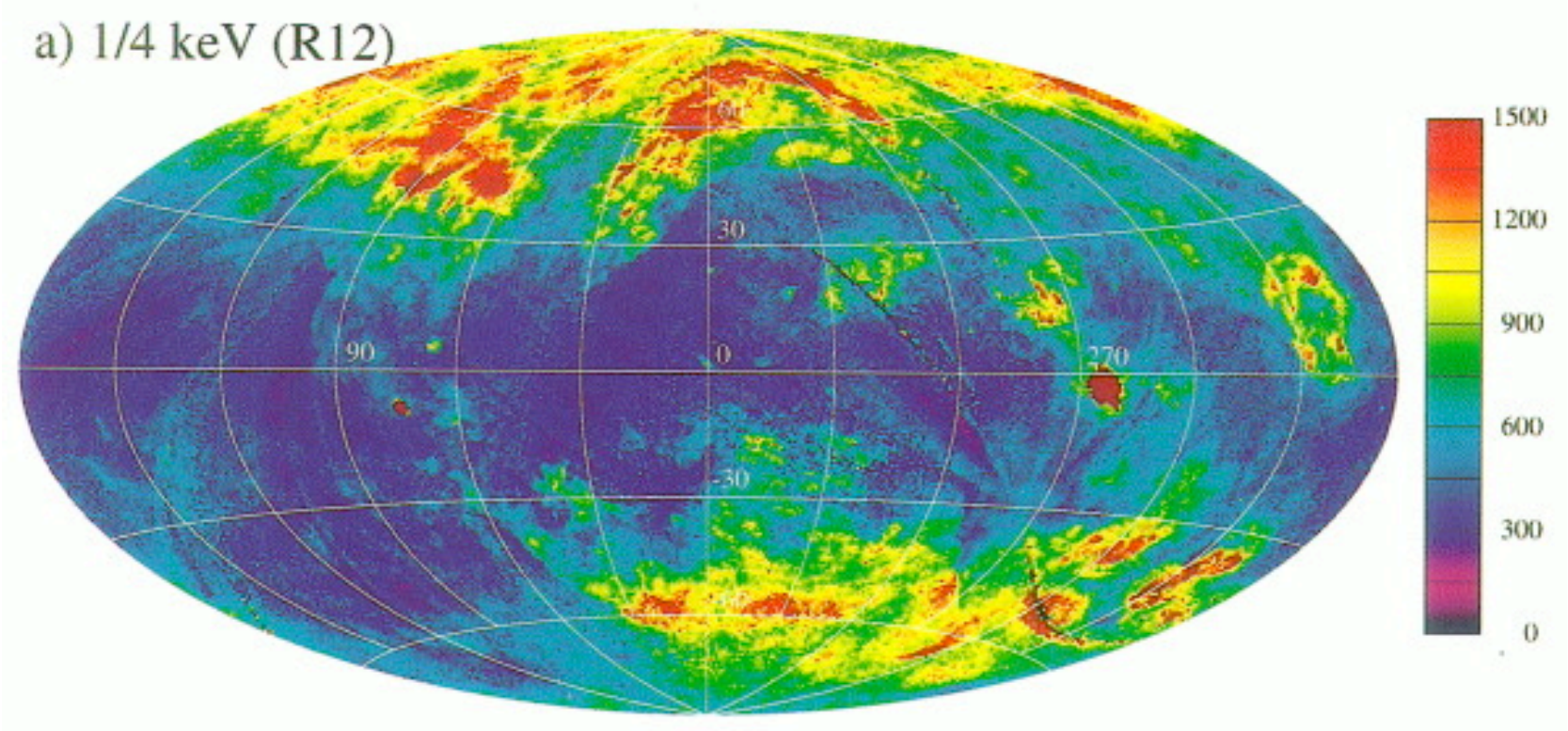
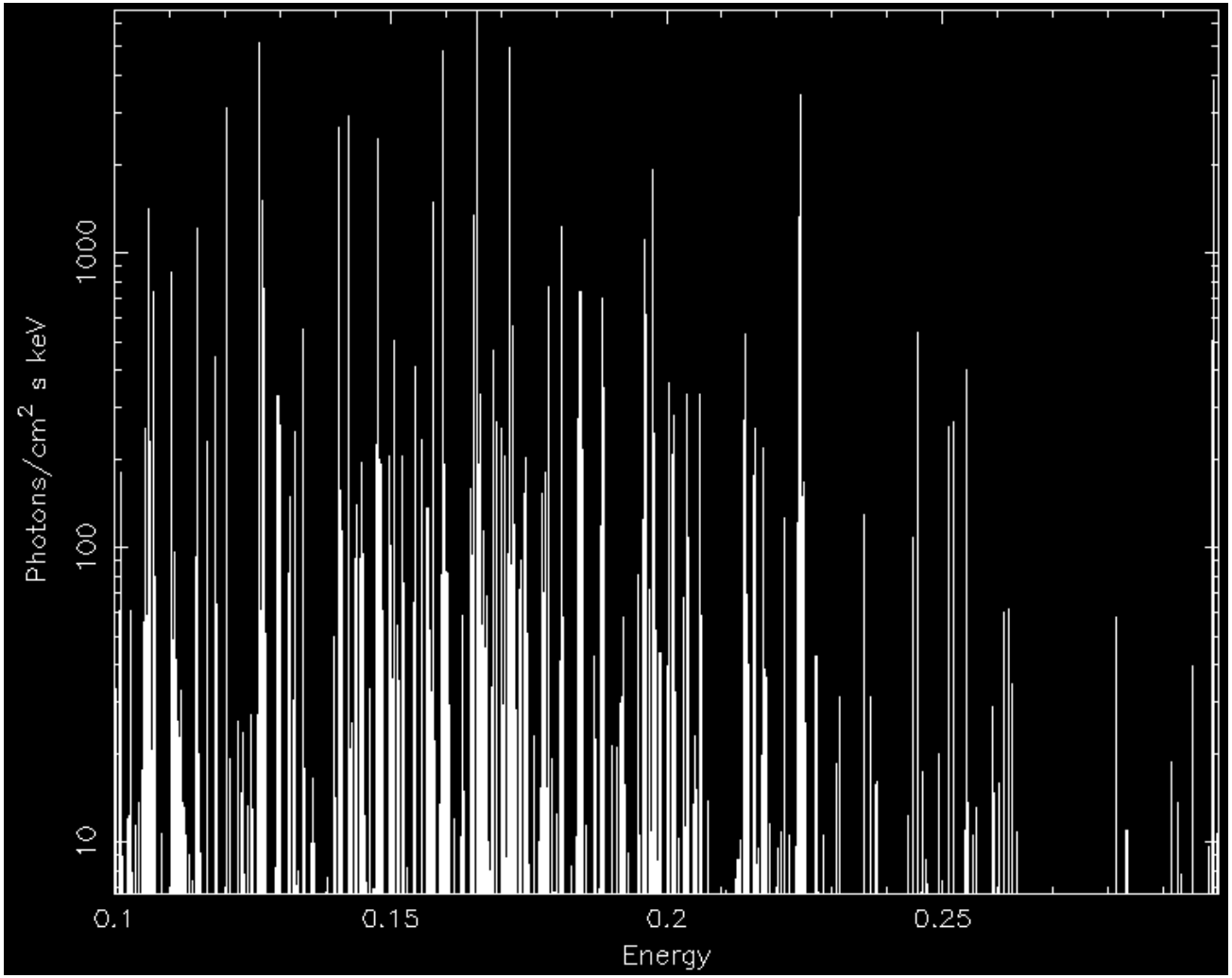
MAKE NO LITTLE PLANS; THEY HAVE NO MAGIC TO STIR A TAC'S BLOOD (PARAPHRASED FROM DANIEL BURNHAM)

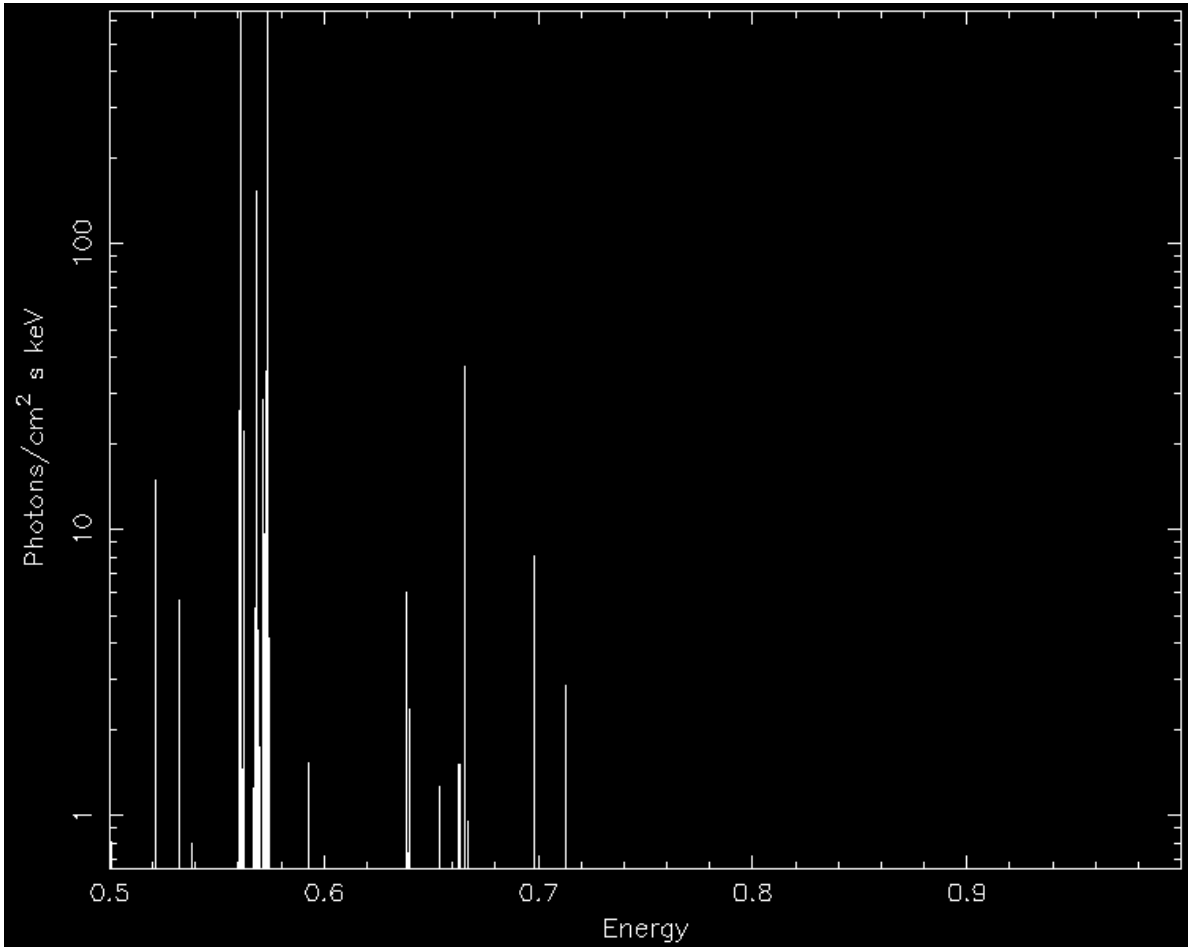


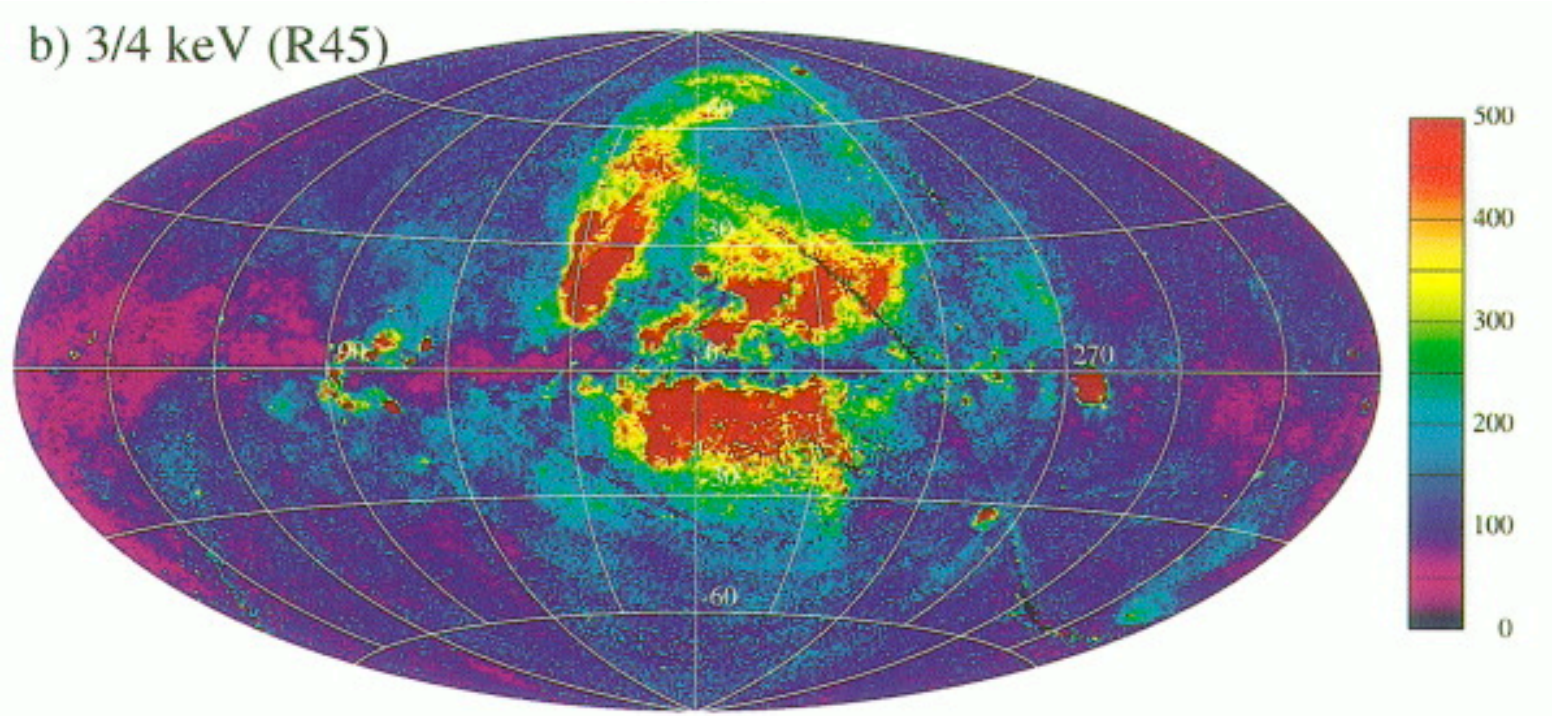
The ROSAT All-sky 1/4 keV image. Some of the emission at high latitudes is from the Galactic halo, although not all. Various SNR can be seen in the plane, but the emission is largely featureless.

The 1/4 keV emission is the signature of the soft X-ray emission. But ***many*** lines contribute to the emission:



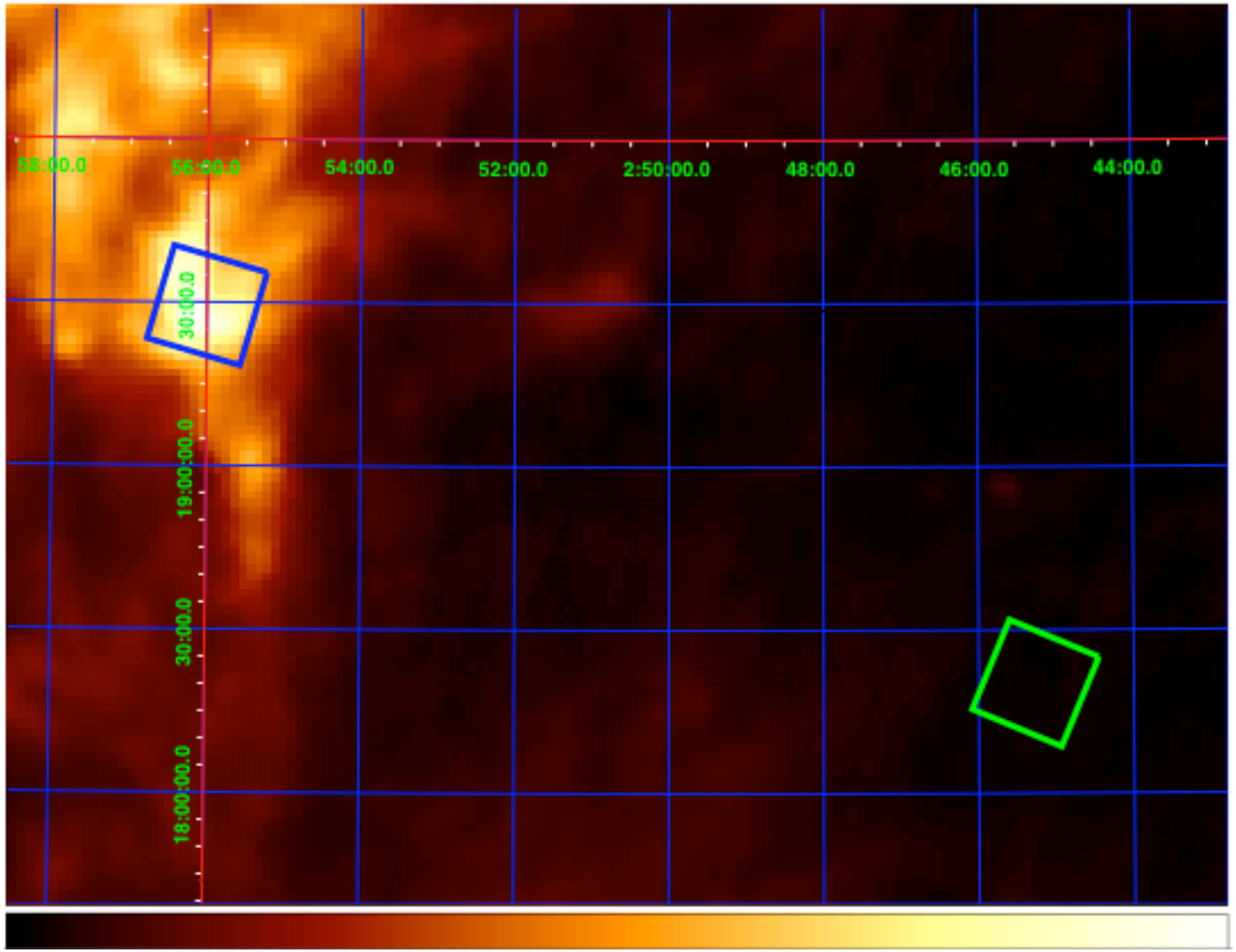
However, in the 3/4 keV range, the situation is much simpler. Practically all the emission is from O VII and O VIII:





ROSAT All-sky Survey in 3/4 keV. Note the relatively small average change with latitude. The brightest features are from Loop I. (Snowden et al. 1997)

IRAS 100 um map of both fields



Processing

- Used XIS1 (BI CCD) data
- Two Observations:

  On-Cloud: Day 208-211 (Feb 3-6)

  Off-Cloud: Day 211-213 (Feb 6-8)
- Only additional bulk filtering was to select the COR>8 data, instead of COR>4.
- Also excluded 2’ radius region around XY Ari in the on-cloud source, and a similar region around an unidentified source in the off-cloud data.

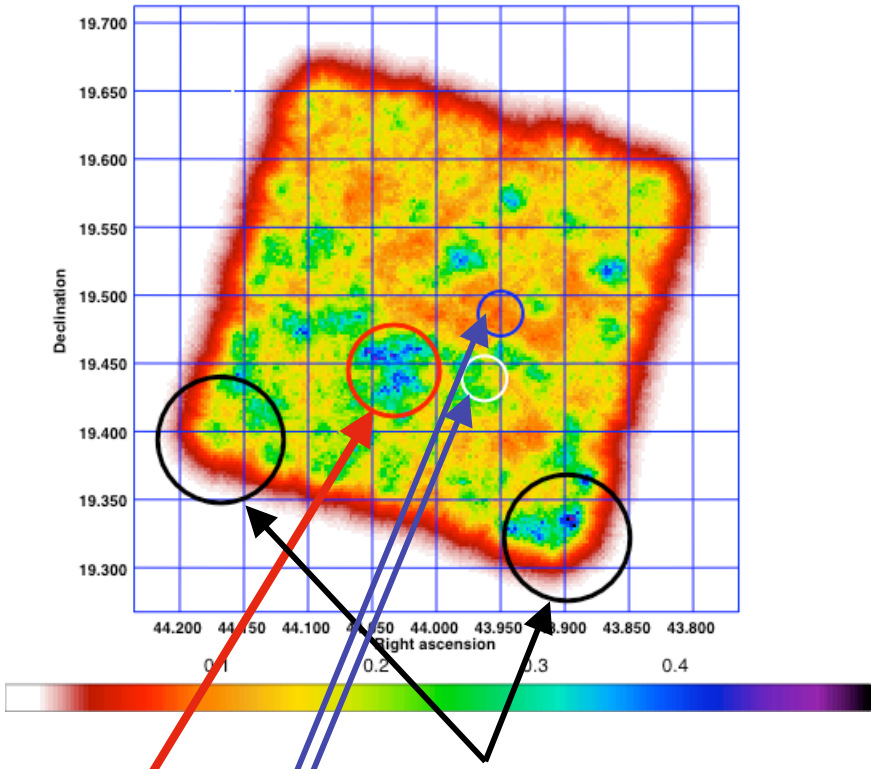
Background

The soft X-ray background is by definition field-filling, the observational background must be estimated independently. It consists of:

- Scattered Solar X-rays
- Cosmic X-ray Background
- Known sources (XY Ari)
- Particle (instrumental) background

Known Sources

On - Cloud

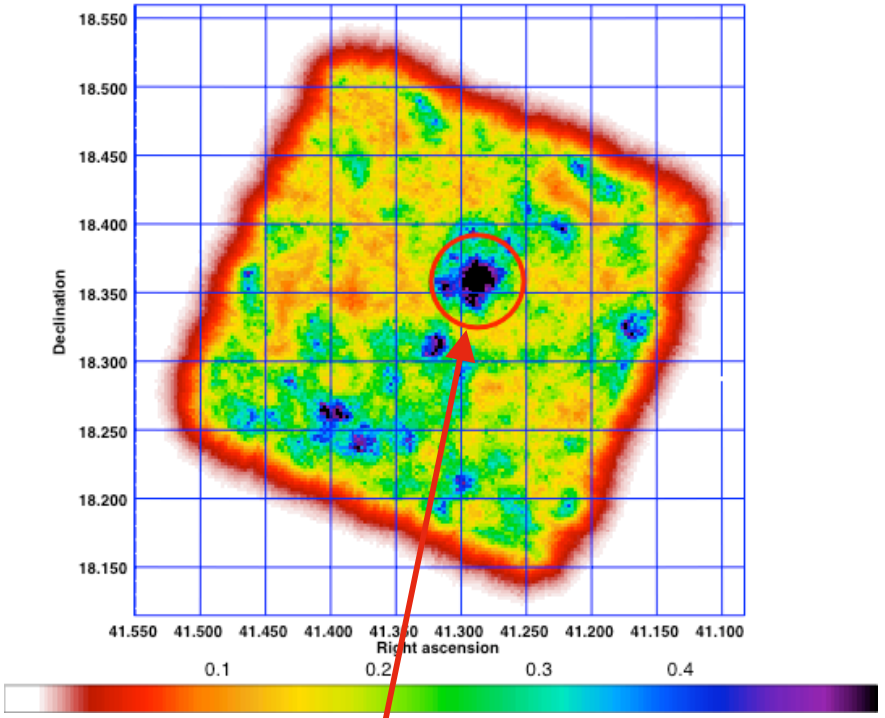


XY Ari

Calibration sources

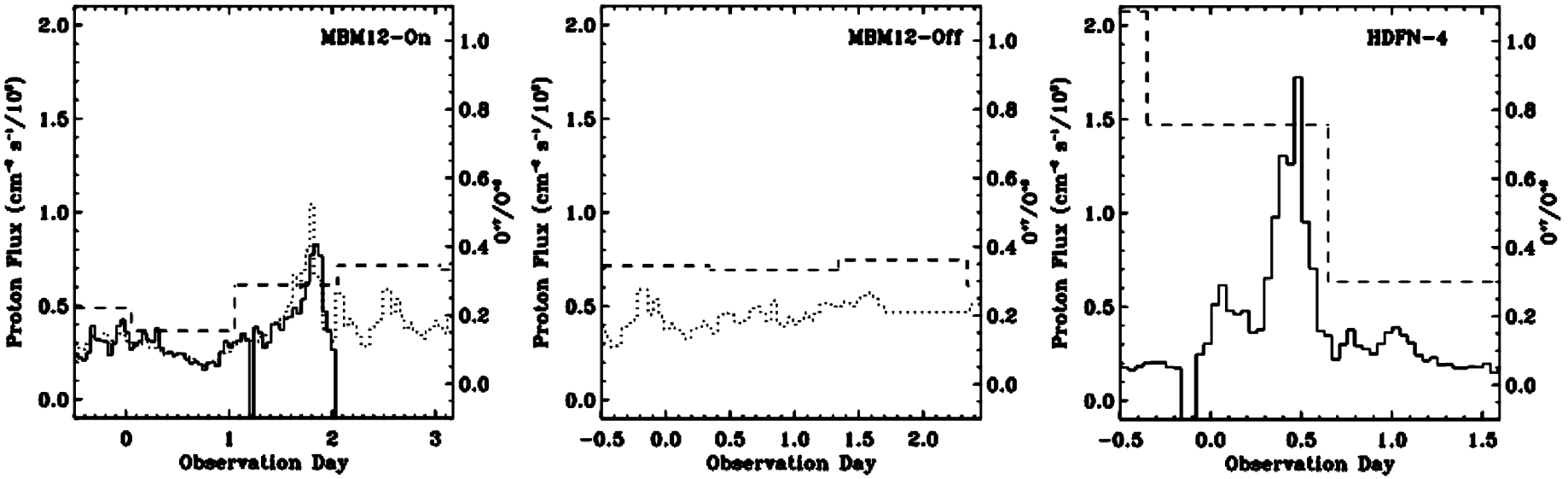
Chandra sources

Off -Cloud



Unidentified source

Solar Wind Charge Exchange

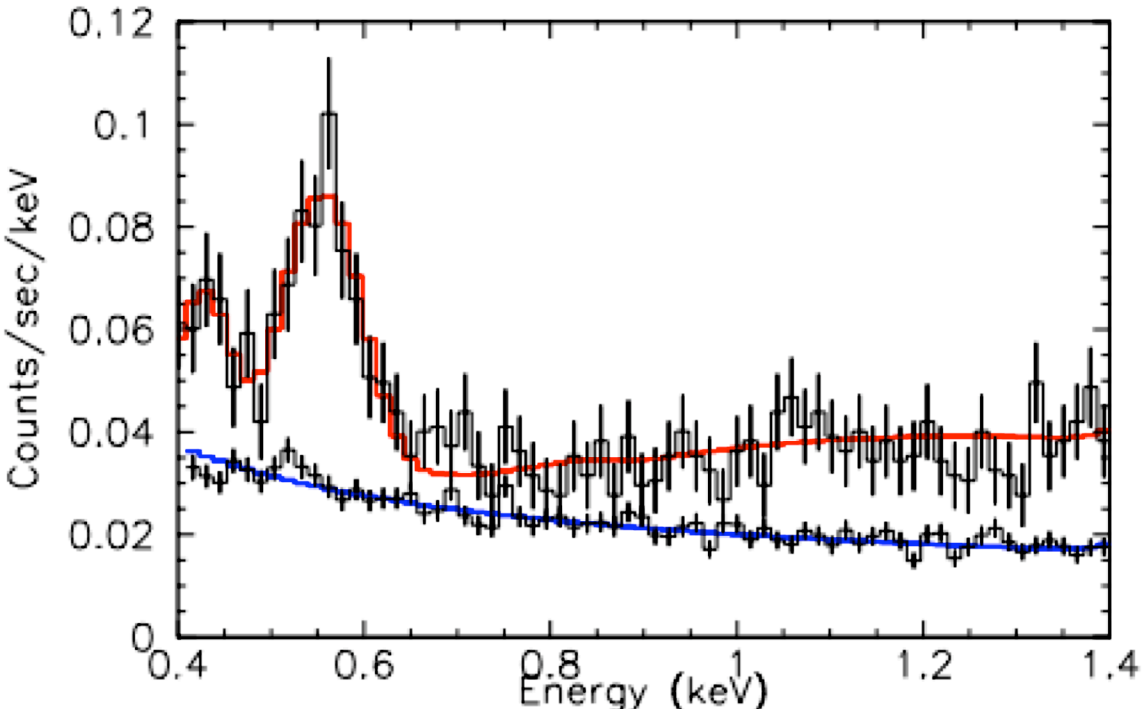


The solid line shows the proton flux in 10^9 cm^{-2}/s from ACE; the dotted line is the same from WIND. The dashed line shows the O^{+7}/O^{+6} ratio from ACE.

Physical model

We excluded a 2’ radius around XY Ari, and fit the result with a model including a O VII line and a low E C/N line, as well as CXRB and scattered XY Ari components:

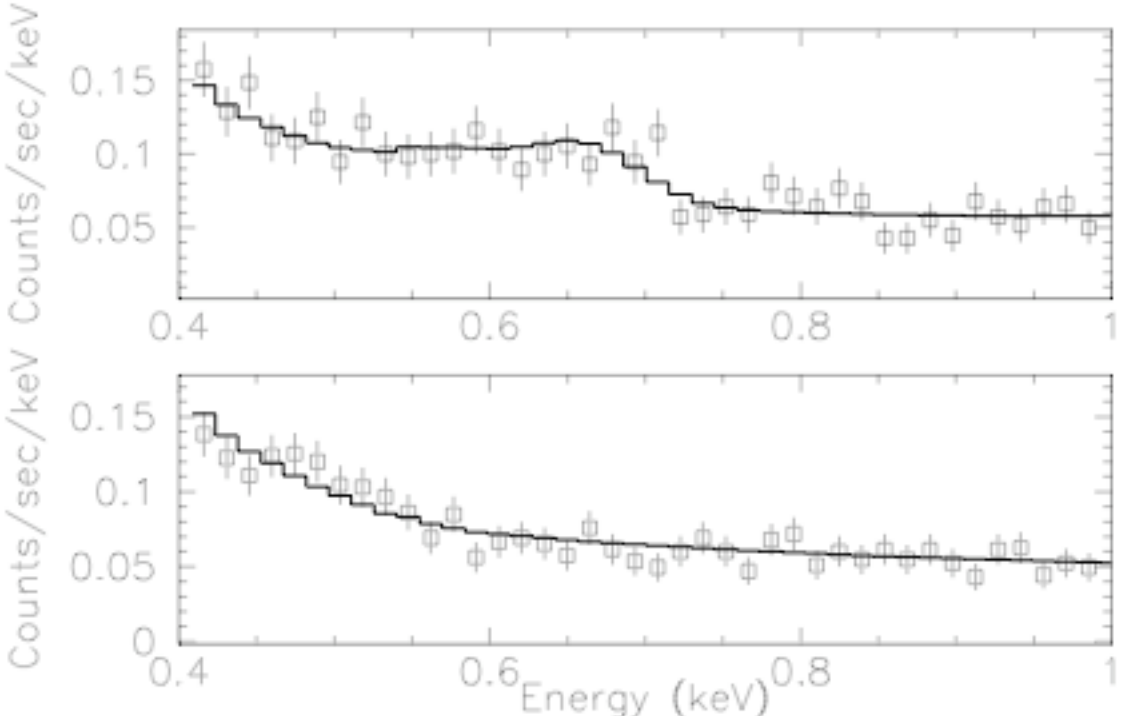
Final O VII surface brightness was 3.53±0.26 LU. A naïve model gives 2.23 ± 0.32 LU, due to the different background model. O VIII is 0.24±0.1LU



Compare to Chandra Results

Chandra observation of MBM12

Chandra background (mostly particle)

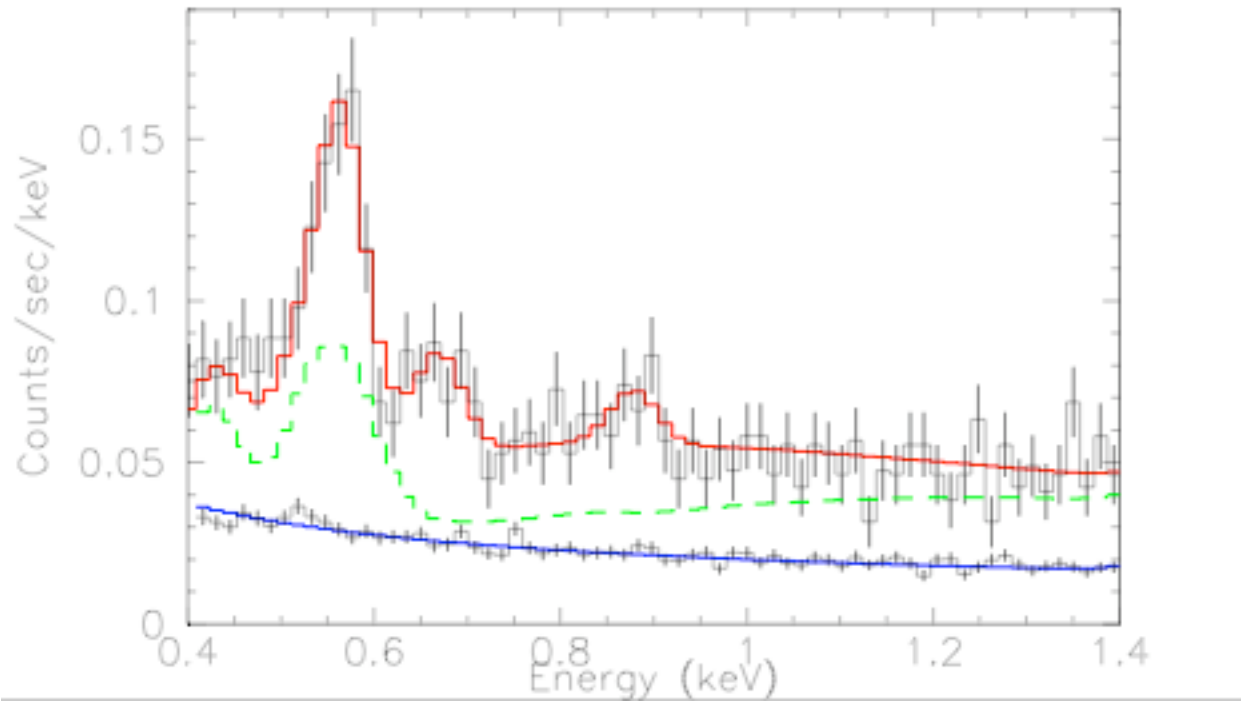


SB(O VII) = 1.92 ± 0.6 ph/cm^2/s/sr

SB(O VIII)= 2.35 ± 0.5 ph/cm^2/s/sr

Off-cloud results

The off-cloud spectra show a clear O VIII line as well as a possible line at 0.876 keV.



Ion	Energy keV	FWHM keV	Flux LU
OVII	$0.562(4)^a$	< 0.001	2.34 ± 0.33
OVIII	0.668(6)	0.02(2)	0.77 ± 0.16
Unknown	0.876(9)	0	0.26 ± 0.08

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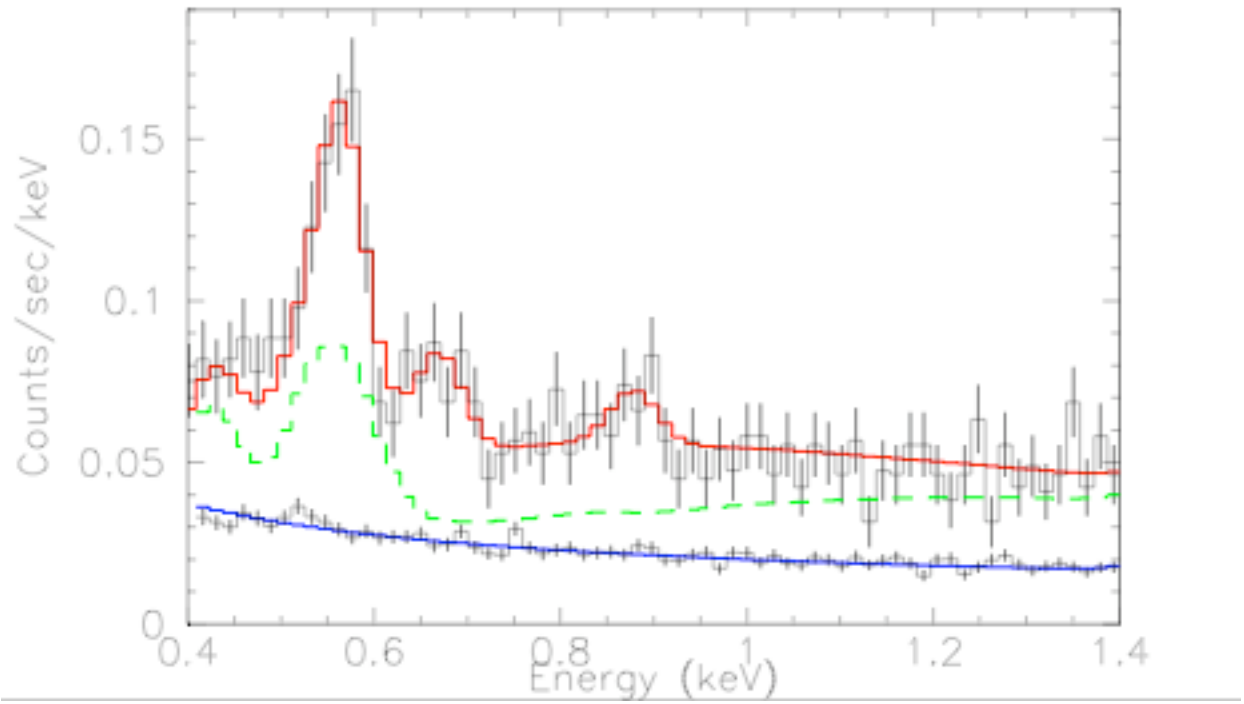

The ratio of the excess O VIII/O VII seen "off-cloud" is consistent with a T ~ 2×10^6 K plasma. The mystery line is probably not from Ne or Fe, since other features from those ions would be seen in this bandpass. Note, however, it is only a 3σ detection.

Conclusions

- If from the LHB, the on-cloud O VII is much stronger than expected, and would predict 1/4 keV band emission **3x** that observed. It also disagrees with the CHIPS upper limit.
- The SWCX explanation also leaves much to be desired since no flare was seen, and no O VIII.
- The off-cloud data show a significant thermal component; most of the excess emission is in the O VII and O VIII features.
- As always…more work is needed (and is ongoing).